



Review

Recent Developments in ZnS-Based Nanostructures Photocatalysts for Wastewater Treatment

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Abstract: The continuous growth of the world population has led to the constant increase of environmental pollution, with serious consequences for human health. Toxic, non-biodegradable, and recalcitrant organic pollutants (e.g., dyes, pharmaceuticals, pesticides) are discharged into water resources from various industries, such as textiles, leather, pharmaceuticals, plastics, etc. Consequently, the treatment of industrial wastewater, via a sustainable technology, represents a great challenge for worldwide research. Photocatalytic technology, an innovative technique based on advanced oxidation process (AOP), is considered a green technology with promising prospects in the remediation of global environmental issues. In photocatalysis, a very important role is attributed to the photocatalyst, usually a semiconductor material with high solar light absorption capacity and conductivity for photogenerated-charge carriers. Zinc sulfide (ZnS), as n-type semiconductor with different morphologies and band gap energies ($E_g = 3.2\text{--}3.71\text{ eV}$), is recognized as a promising photocatalyst for the removal of organic pollutants from wastewater, especially under UV light irradiation. This review deals with the recent developments (the last five years) in ZnS nanostructures (0D, 1D, 3D) and ZnS-based heterojunctions (n-n, n-p, Z-scheme) used as photocatalysts for organic pollutants' degradation under simulated (UV, Vis) and sunlight irradiation in wastewater treatment. The effects of different synthesis parameters (precursors' type and concentration, capping agents' dosages, reaction time and temperature, metal doping, ZnS concentration in heterostructures, etc.) and properties (particle size, morphology, band gap energy, and surface properties) on the photocatalytic performance of ZnS-based photocatalysts for various organic pollutants' degradation are extensively discussed.

Keywords: ZnS nanostructures; heterojunctions; photocatalysis; organic pollutants; wastewater treatment



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1. Introduction

Wastewater loaded with toxic, non-biodegradable organic pollutants represents a real problem, both for aquatic environments and for human life and development. Industrial wastewater originates mainly from the textile industry, but also from the plastics, paper, food, and cosmetic industries, due to the large amount of water used in the various technological stages, especially during the dyeing process [1]. It has been estimated that the wastewater from textile production contributes approximately 20% of the total industrial polluted water [2].

The presence of a very small concentration of organic dyes in water (less than 1 ppm for some dyes) may have serious consequences for the environment, but more for the population health, such as skin and eyes irritations, respiratory and gastric tracts affections, quadriplegia, tachycardia, tissue necrosis, and cancer [3–4].

The dyes most used industrially are azo dyes (usually with an aromatic structure) which, under natural conditions, require a long time to degrade due to their high photosta-

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